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Reed

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(54) **METHOD AND APPARATUS FOR FLEXIBLE LED LAMP**

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(51) **Int. Cl.**[7] **F21L 4/04**

(52) **U.S. Cl.** **362/198**; 362/394; 362/246; 362/205; 362/251; 362/396

(58) **Field of Search** 362/395, 191, 362/198, 184, 230, 246, 394, 205, 33, 97, 194, 234, 251, 253, 800, 396

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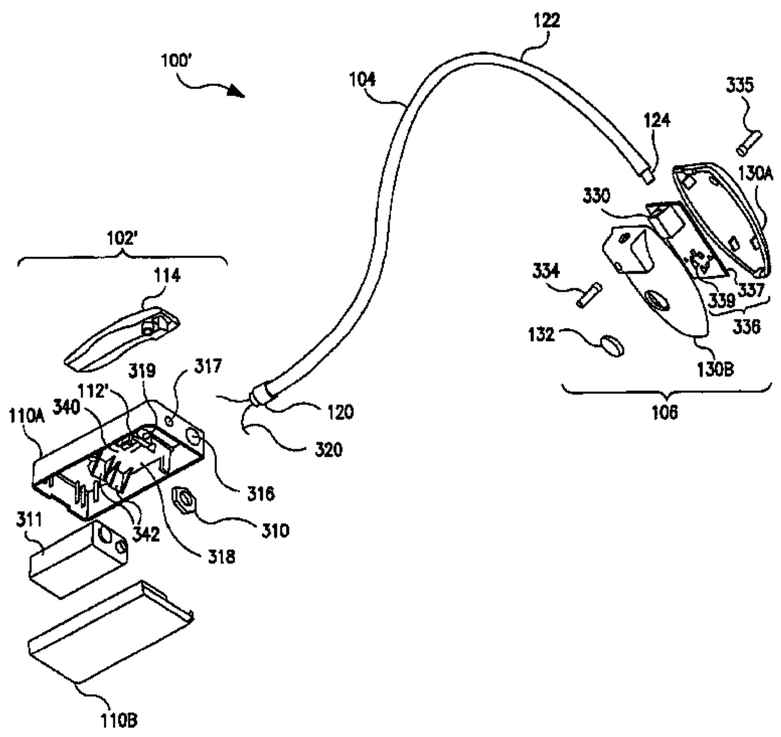
(57) **ABSTRACT**

A flexible light emitting diode (LED) lamp. The flexible LED lamp includes a base, an LED lamp head, and a flexible mid region disposed between the base and the LED lamp head. The LED lamp head is detachable or replaceable to obtain different colors, upgrade to improved LED lighting technology, or replace a defective component. The LED lamp head includes one or more LEDs coupled to a printed circuit board and a lens to spread the light generated by the LEDs to provide a larger area of illumination. The base of the flexible LED lamp has a clip to couple an object, such as a music stand, table or a book case. The flexible mid region allows the LED lamp head to be moved into a position where illumination is desired.

68 Claims, 10 Drawing Sheets



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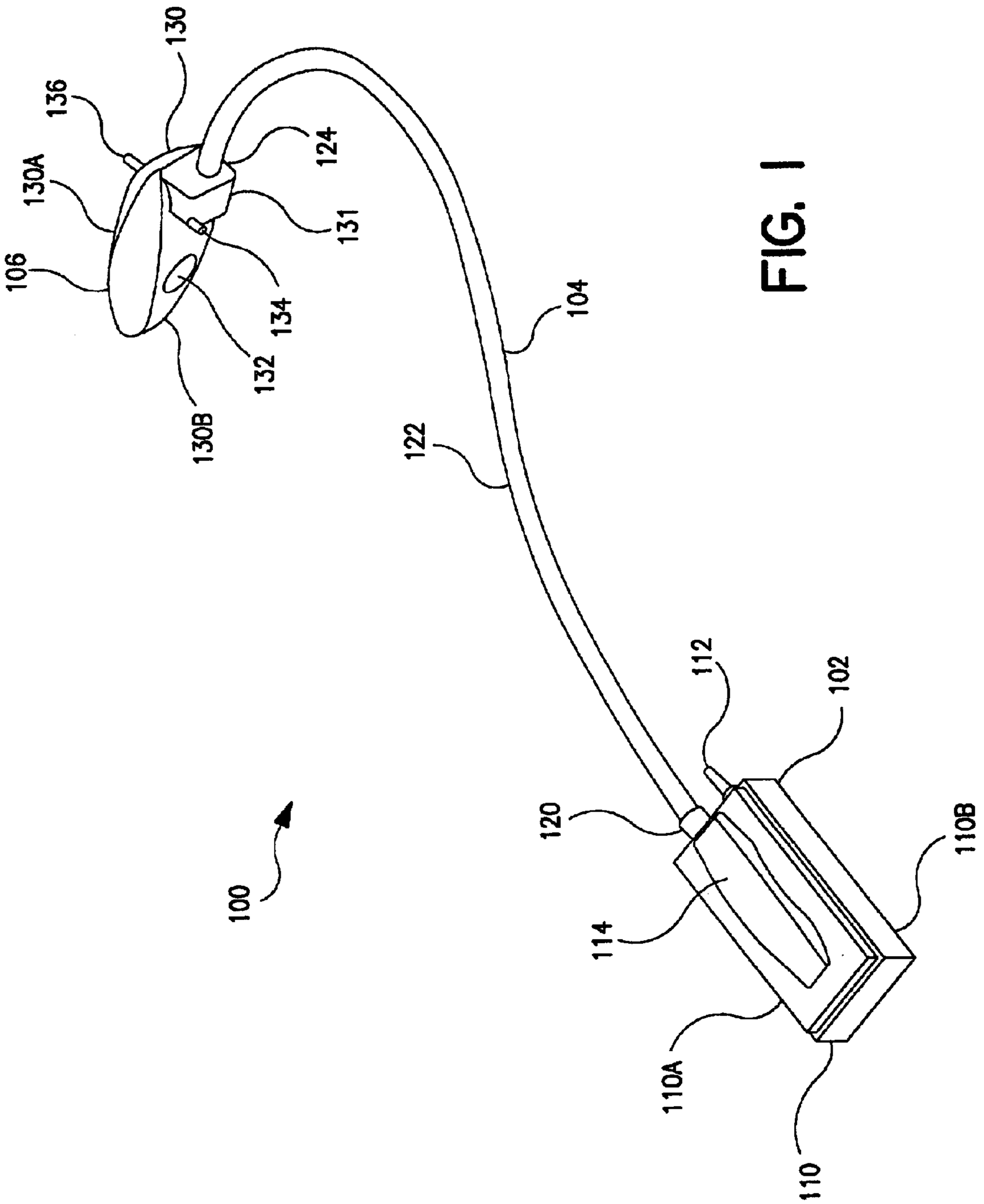
100
106
136
130
130A
130B
124
131
132
134
104
122
112
102
120
114
110A
110
110B

FIG. 1

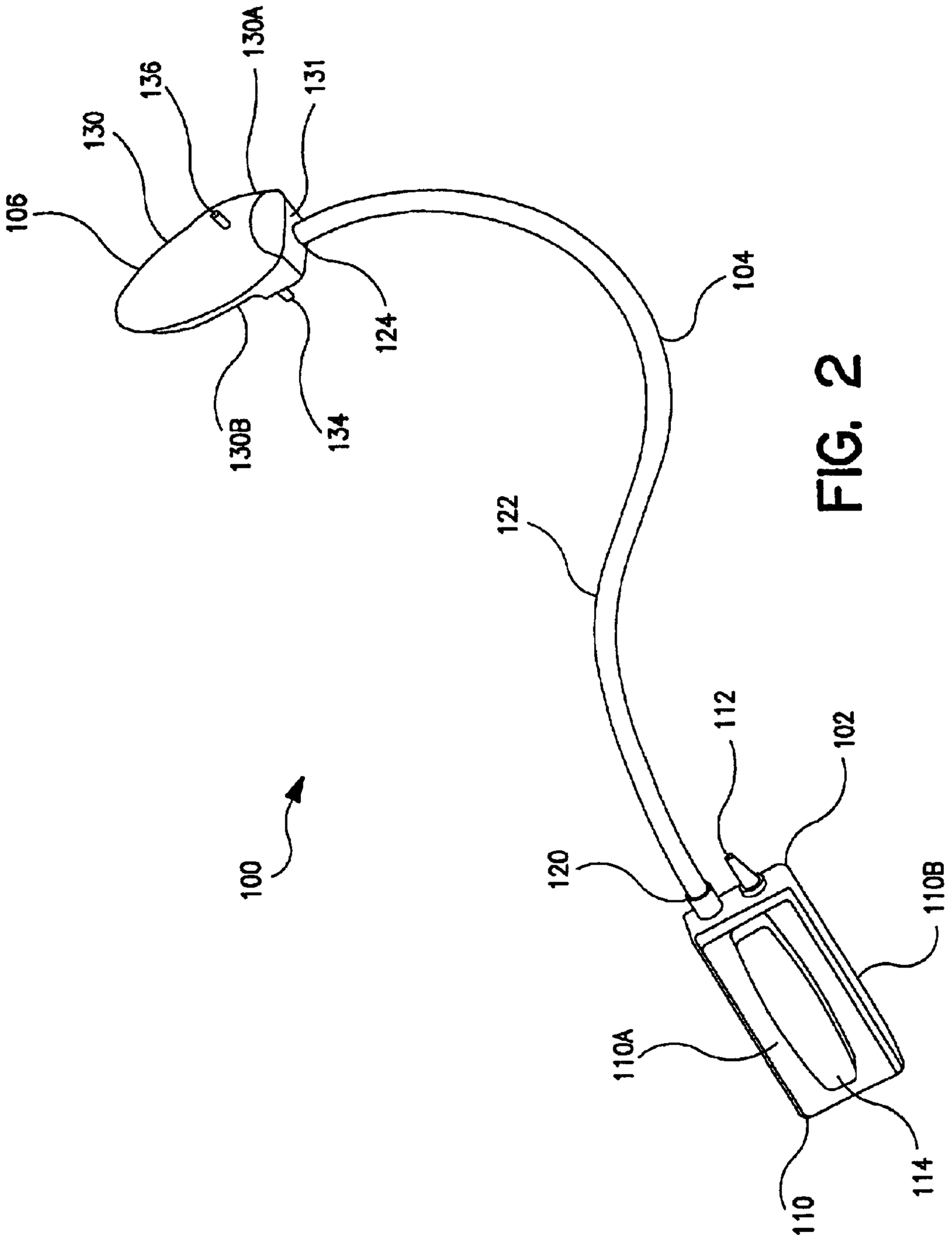
100
106
130
136
130A
131
1308
134
124
104
122
112
102
120
110B
110A
110
114

FIG. 2

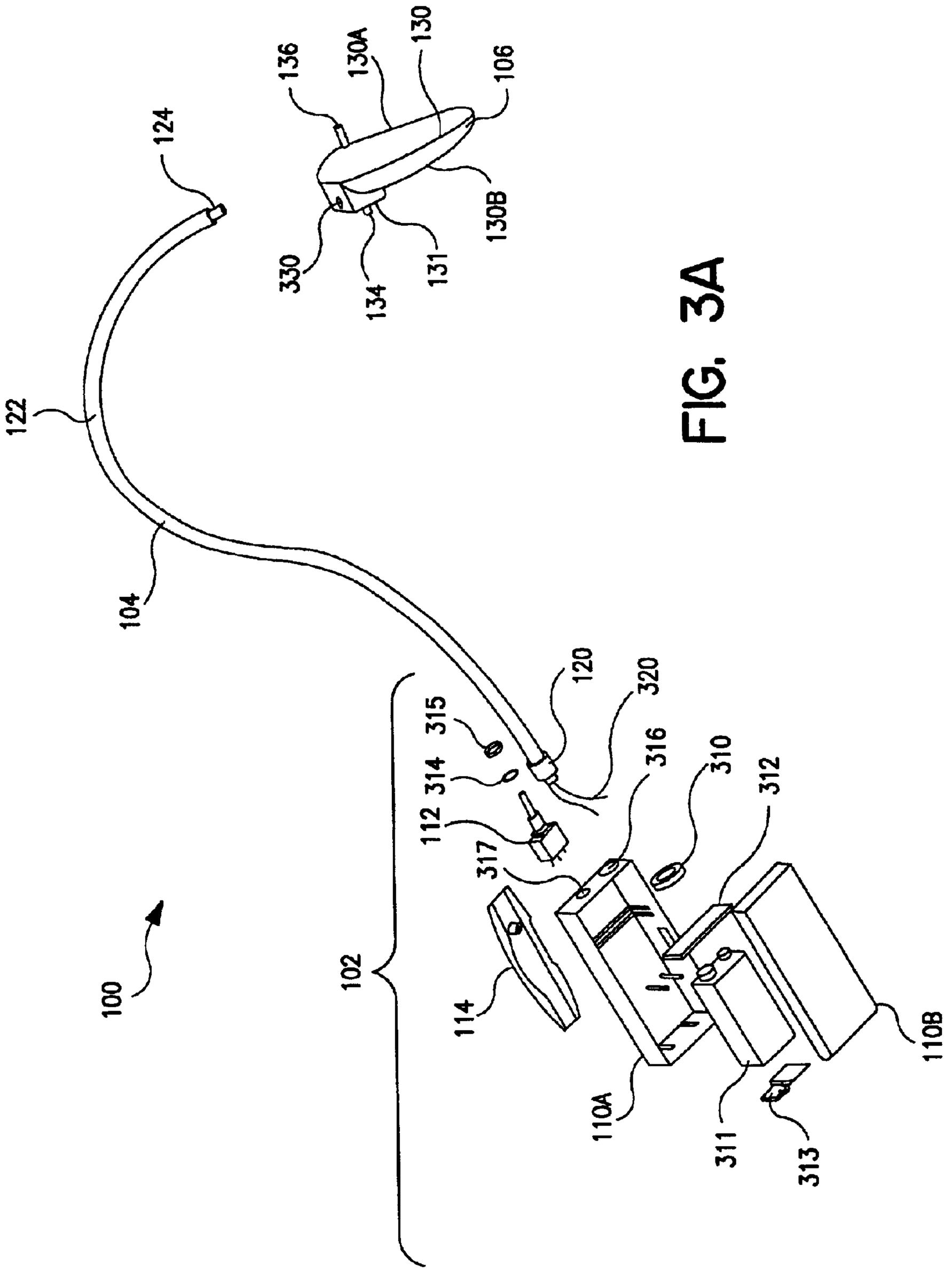
100
102
104
106
108
110A
110B
112
114
120
122
124
130
130A
130B
131
134
136
310
311
312
313
314
315
316
317
320
330

FIG. 3A

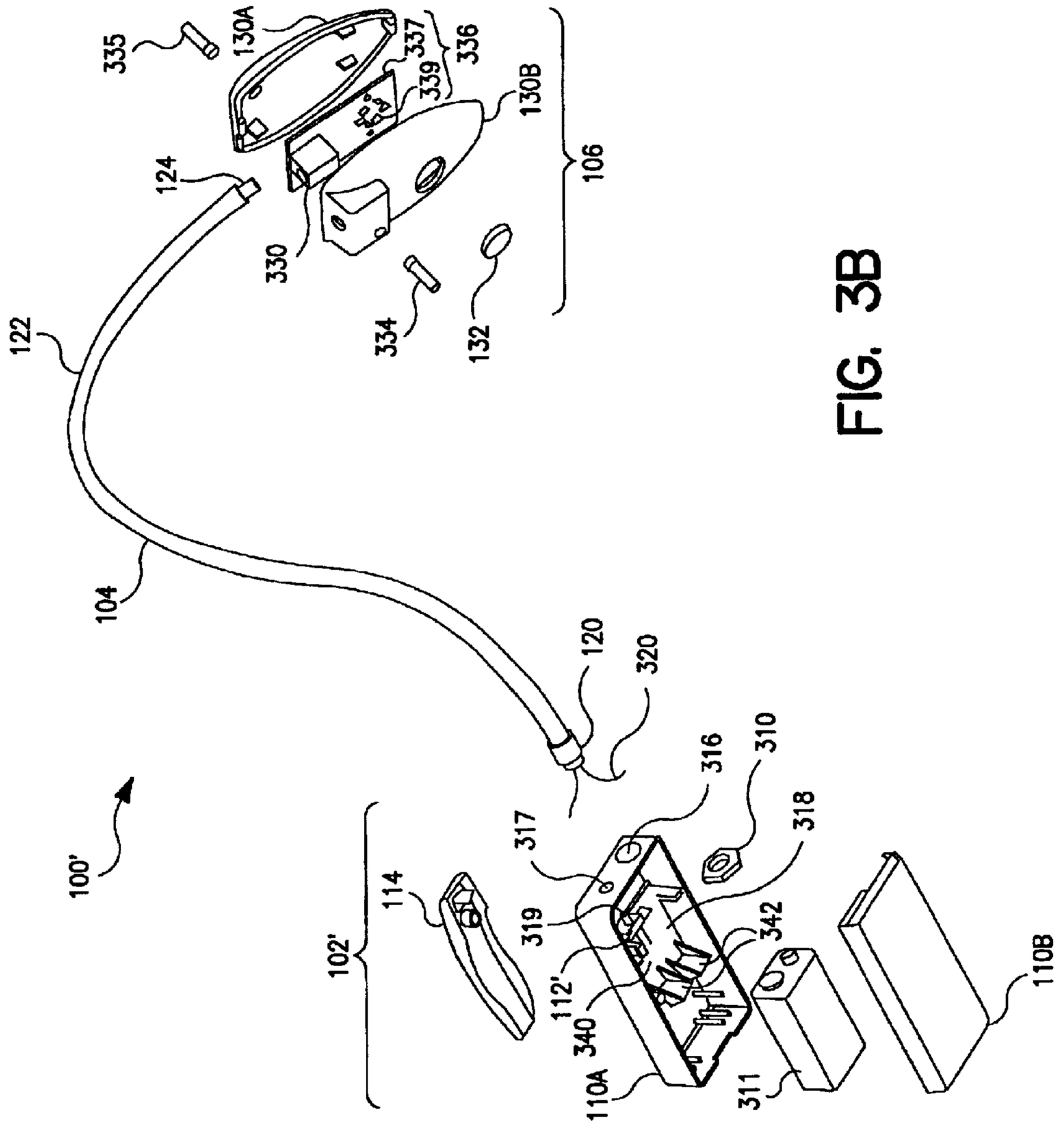
100'
102'
104
106
110A
110B
112'
114
120
122
124
130A
130B
132
310
311
316
317
318
319
320
330
334
335
336
337
339
340
342

FIG. 3B

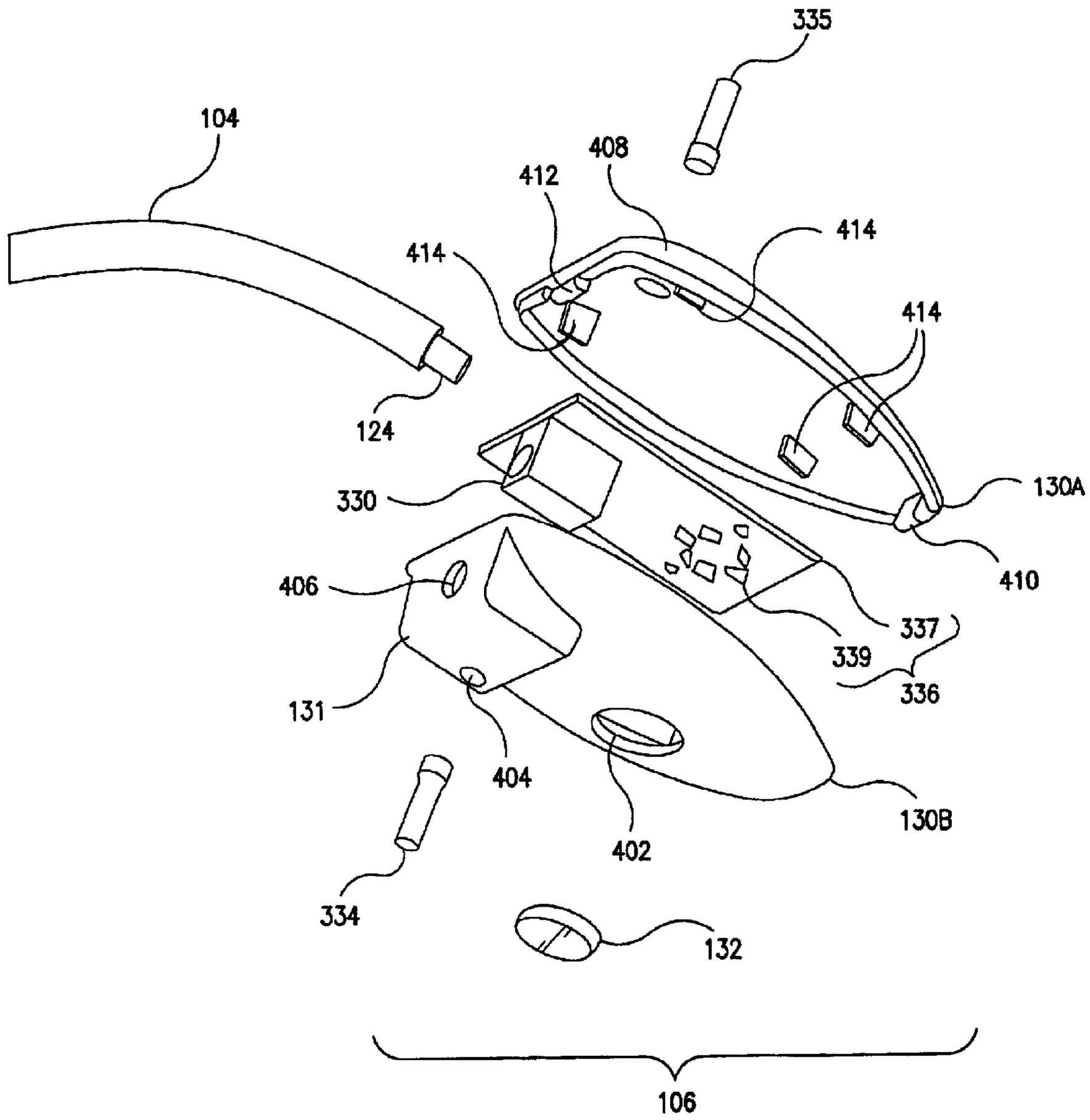
335
104
408
412
414
414
414
124
330
130A
410
406
337
339
336
131
404
130B
402
334
132
106

FIG. 4

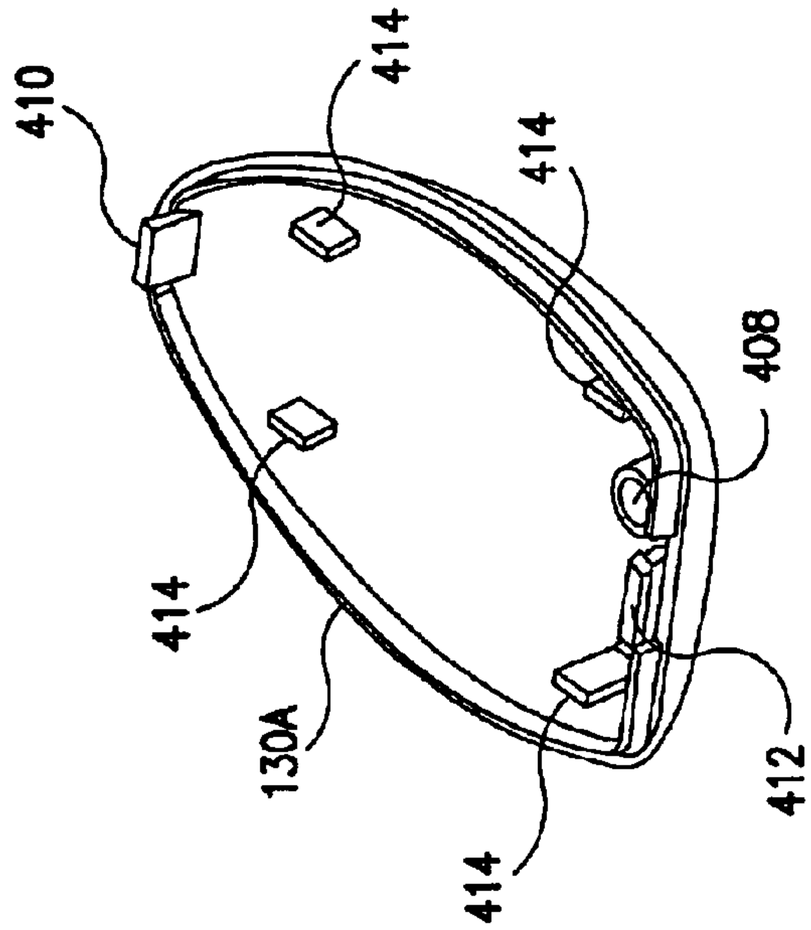
410
414
414
408
414
130A
412
414

FIG. 5B

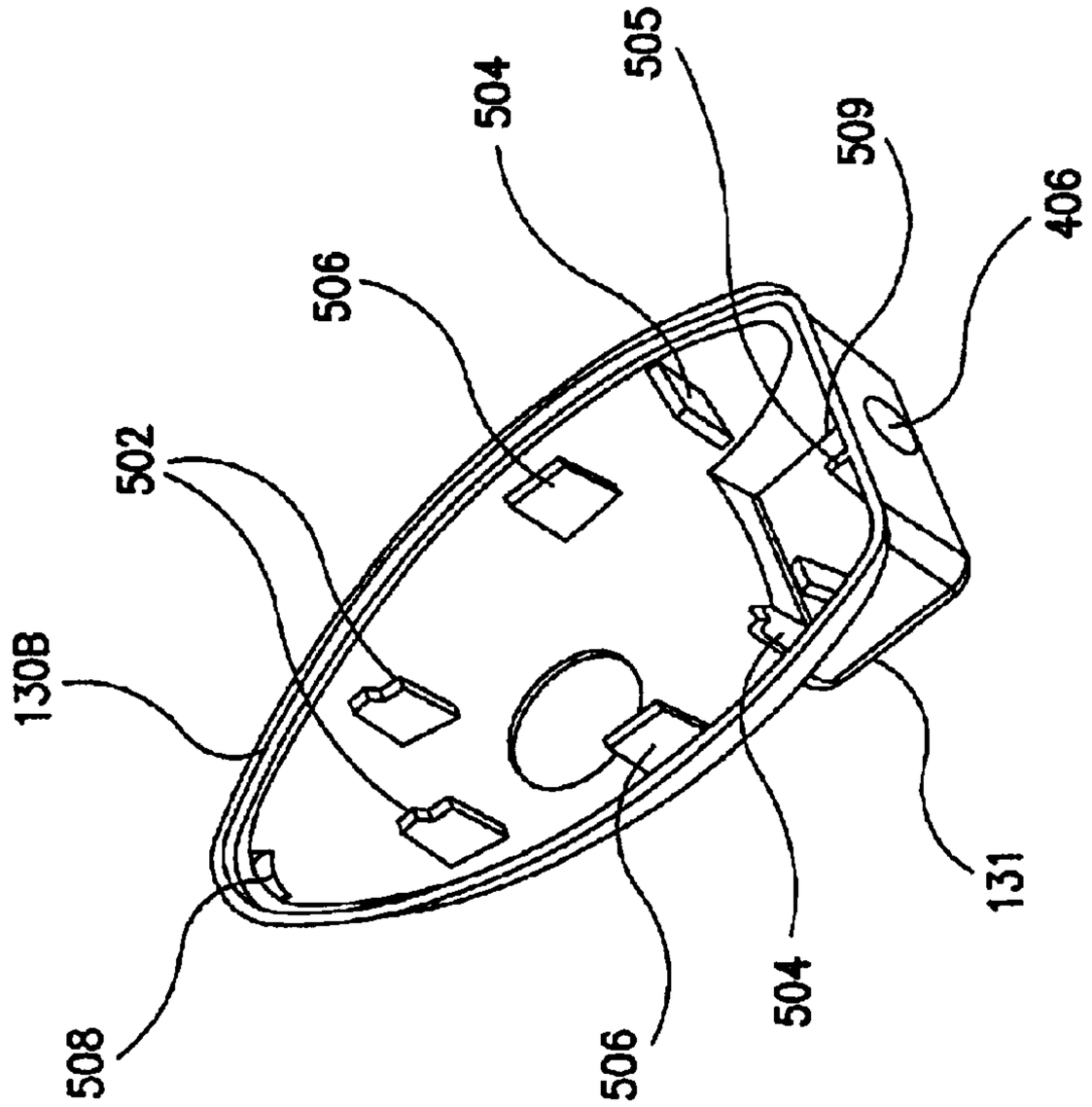
504
505
509
406
506
502
130B
508
506
504
131

FIG. 5A

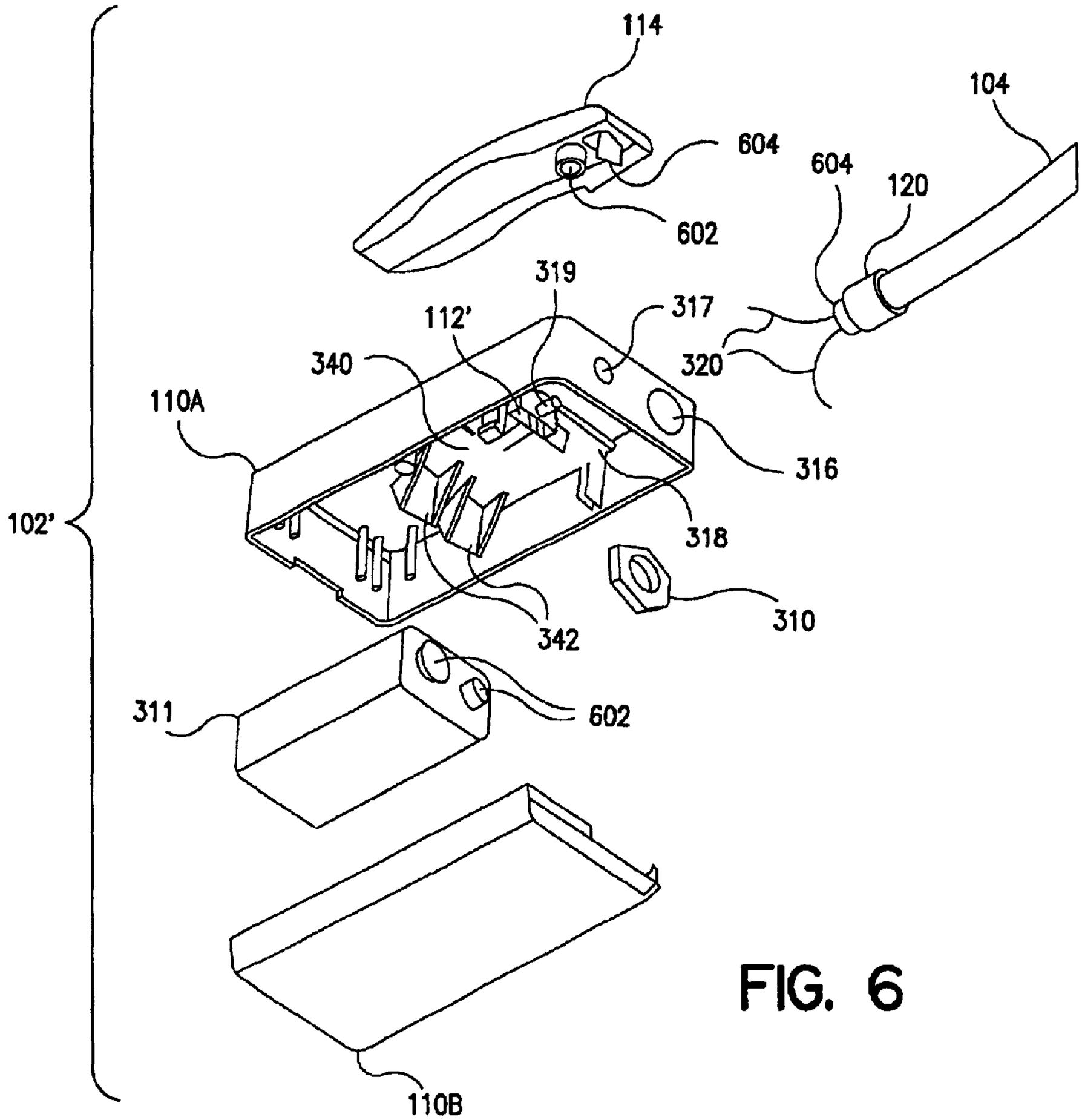
102'
114
104
604
604
120
602
319
317
112'
340
320
110A
316
318
310
342
311
602
110B

FIG. 6

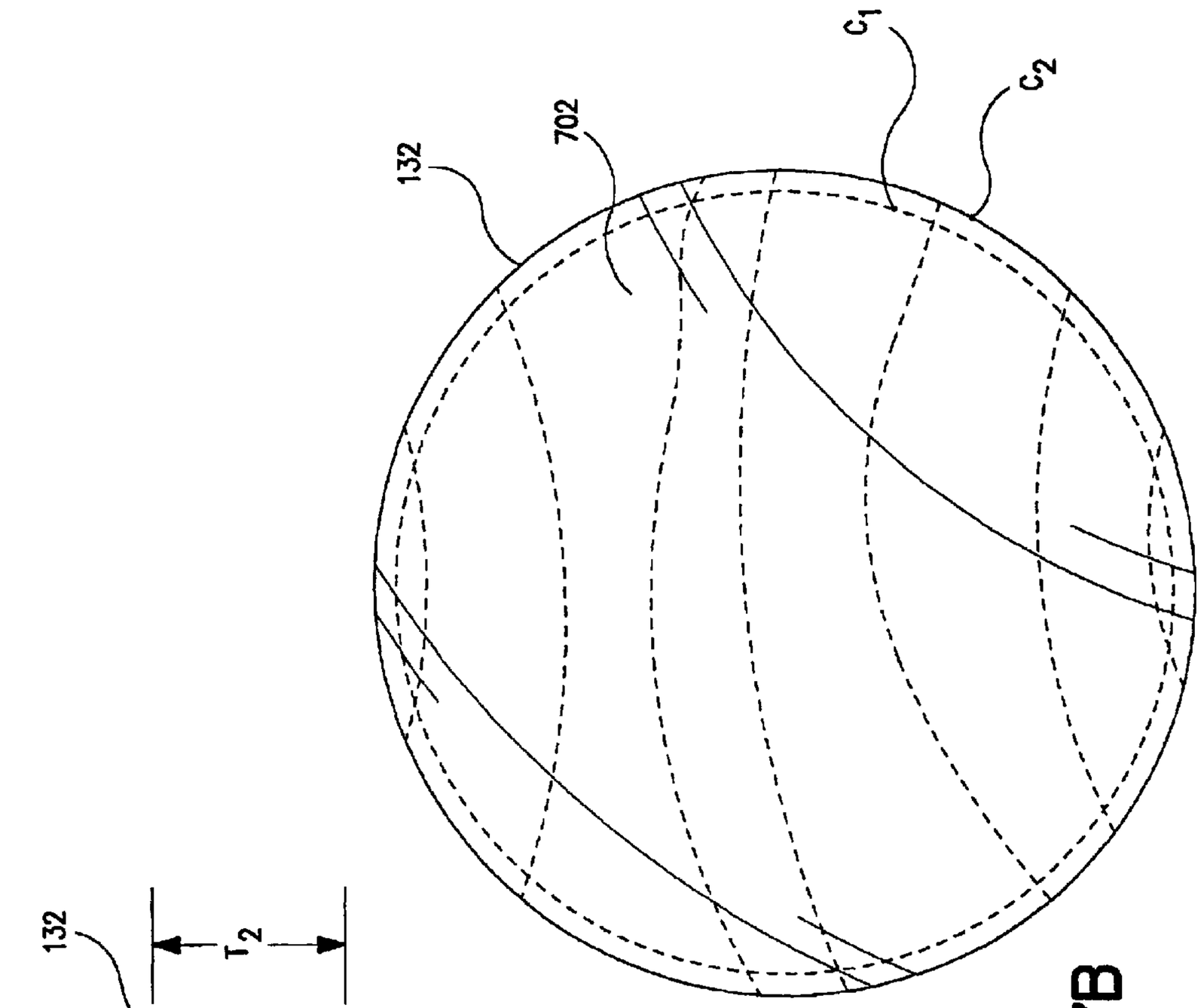

FIG. 7B

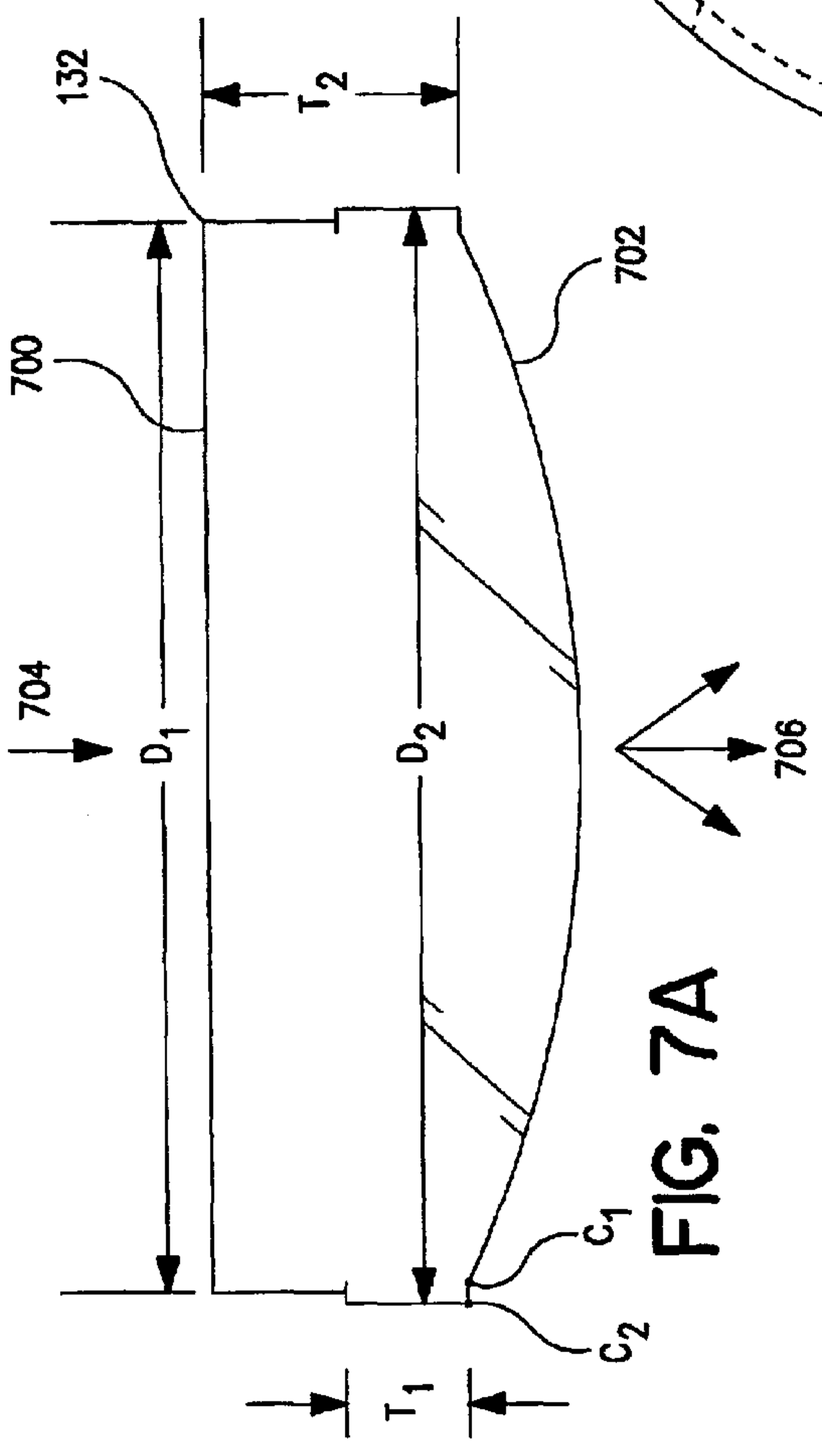

FIG. 7A

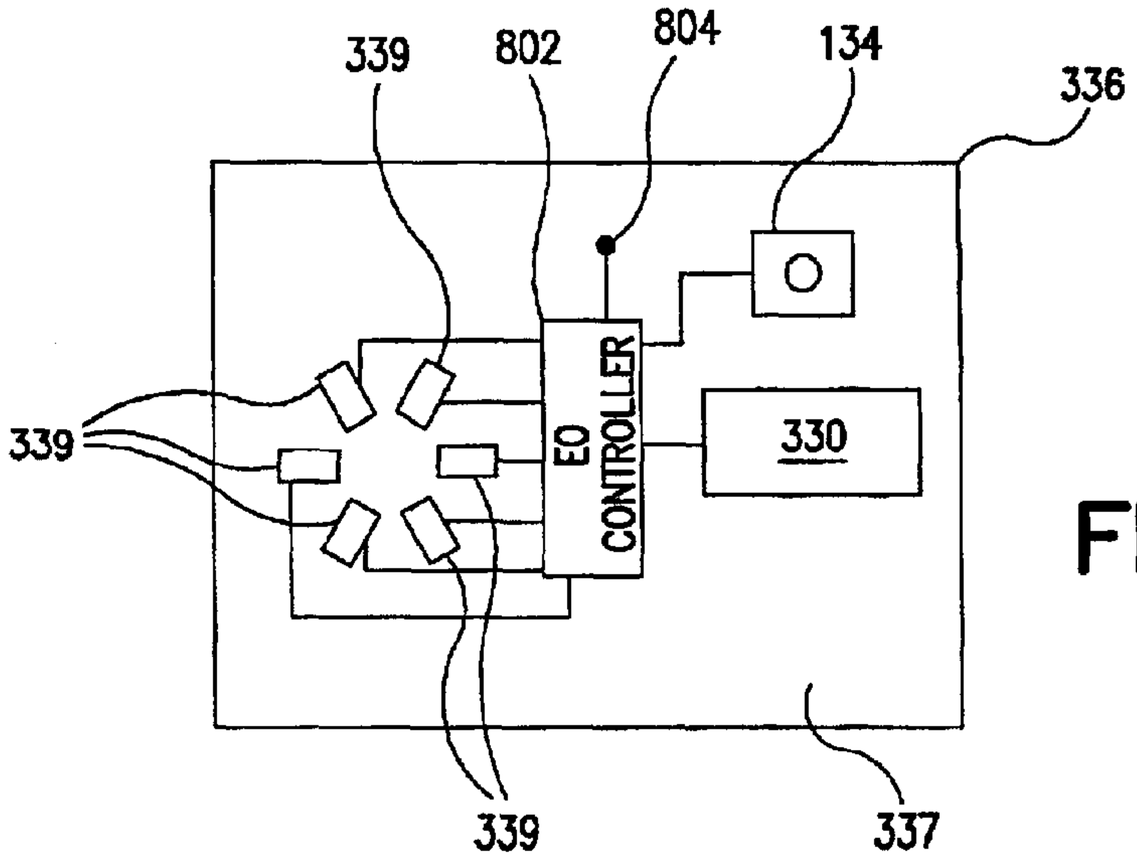

FIG. 8A

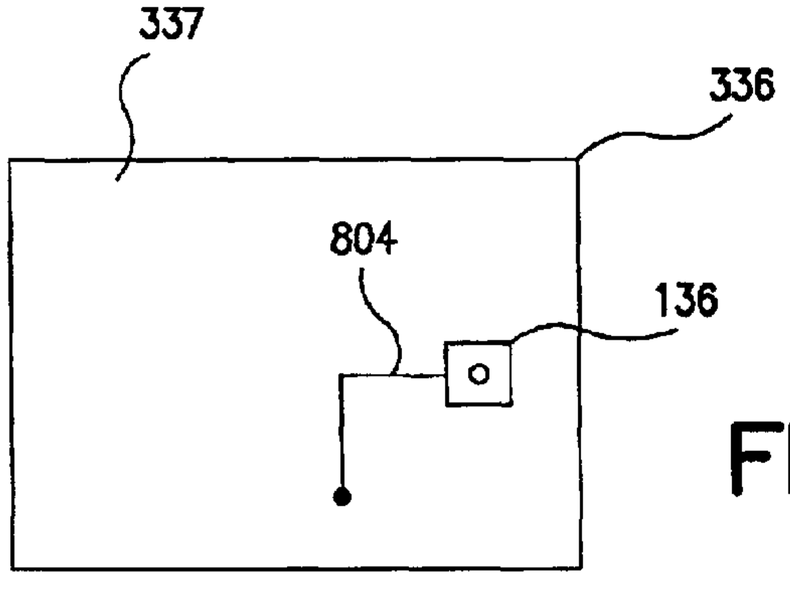

FIG. 8B

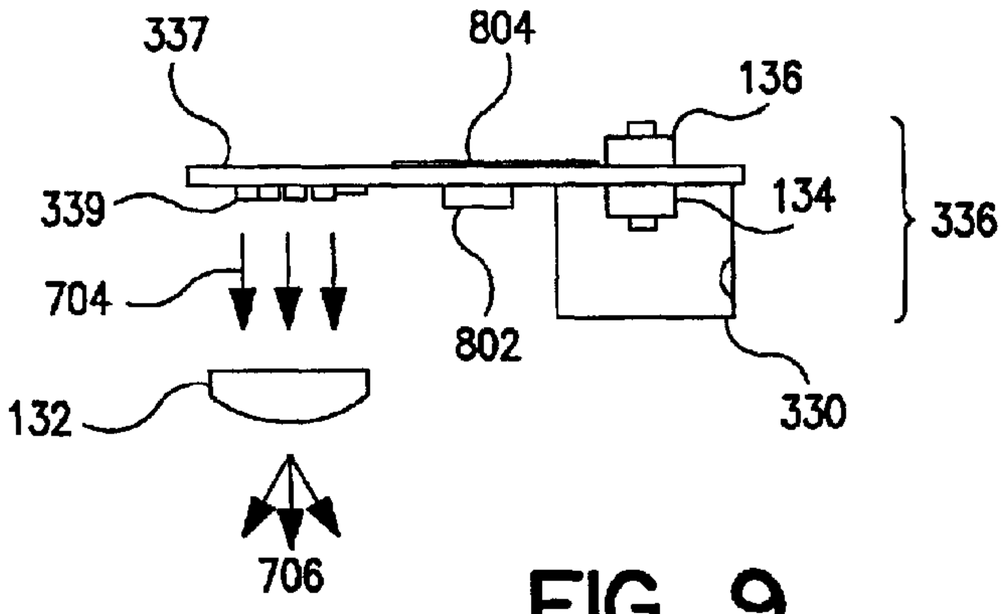

FIG. 9

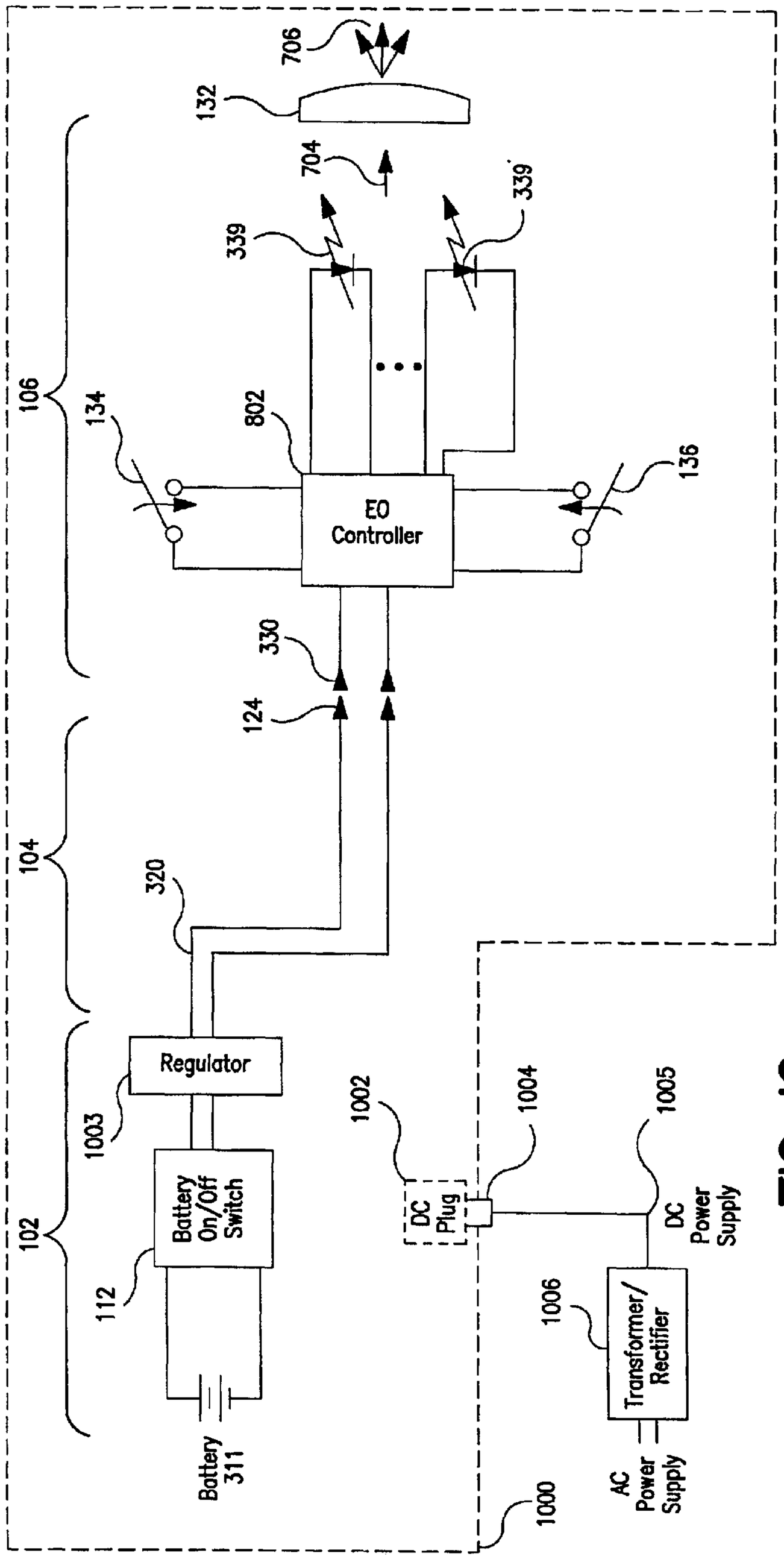
706
132
704
339
339
106
134
802
136
EO Controller
330
124
104
320
Regulator
1003
1002
1004
1005
102
Battery On/Off Switch
DC Plug
DC Power Supply
112
1006
Transformer/ Rectifier
Battery 311
AC Power Supply
1000

FIG. 10

METHOD AND APPARATUS FOR FLEXIBLE LED LAMP

CROSS-REFERENCE TO RELATED APPLICATIONS

This United States (US) non-provisional patent application filed by David Reed claims the benefit of U.S. provisional patent application Ser. No. 60/306,800, filed by David Reed on Jul. 20, 2001, entitled "METHOD AND APPARATUS FOR FLEXIBLE LED LAMP".

FIELD OF THE INVENTION

The invention relates generally to the field of lighting. Particularly, the invention relates to flexible lamps.

BACKGROUND OF THE INVENTION

Prior flexible lamps have typically provided illumination by using fluorescent, incandescent or halogen lighting technology. These types of lighting technology use fluorescent, incandescent or halogen bulbs, respectively. These bulbs tend to be fragile and can break if not carefully handled. Furthermore, these bulbs have a limited lifetime and can burn out when filaments therein are depleted and break. Once burned out, a new bulb needs to replace the burned out bulb before the lamp can function again.

Additionally, incandescent and halogen lighting are inefficient lighting technologies. The inefficiency results in the generation of heat. The heat generated tends to make bulbs hot to touch and may require shielding. Fluorescent fixtures are oftentimes noisy due to the balances and they sometimes emit radio frequency interference which can interfere with desirable radio frequency signals.

Furthermore, halogen lighting requires a significant power source and is not often used in battery operated applications. While fluorescent and incandescent lighting are used in battery operated applications, further improvement in energy efficiency is desirable to extend battery life and reduce energy costs from power line sources.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a flexible LED lamp.

FIG. **2** is another perspective view of the flexible LED lamp.

FIG. **3**A is a disassembled illustration of the flexible LED lamp with an exploded view of a base.

FIG. **3**B is a disassembled illustration of the flexible LED lamp with an exploded view of an alternate base.

FIG. **4** is a magnified exploded view of the LED lamp head and a portion of the flexible mid region.

FIG. **5**A is a top view of the lower-half lamp housing for the LED lamp head.

FIG. **5**B is a top view of the upper-half lamp housing for the LED lamp head.

FIG. **6** is a magnified exploded view of the alternate base and a portion of the flexible mid region.

FIG. **7**A is a cross section of the lens.

FIG. **7**B is a bottom view of the lens.

FIG. **8**A is a bottom view of the lamp head electrical subassembly.

FIG. **8**B is a top view of the lamp head electrical subassembly.

FIG. **9** illustrates a side view of the lamp head electrical subassembly aligned with the optical axis of the lens.

FIG. **10** is a system block diagram of the flexible LED lamp and optional external components.

Like reference numbers and designations in the drawings indicate like elements providing similar functionality.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of the invention, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it is to be understood that the invention may be practiced without these specific details. In other instances well known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the invention.

A flexible light emitting diode (LED) lamp. The flexible LED lamp includes a base, an LED lamp head, and a flexible mid region disposed between the base and the LED lamp head. The LED lamp head is detachable or replaceable to obtain different colors, upgrade to improved LED lighting technology, or replace a defective component. The LED lamp head includes one or more LEDs coupled to a printed circuit board and a lens to spread the light generated by the LEDs to provide a larger area of illumination. The base of the flexible LED lamp has a clip to couple an object, such as a music stand, table or a book case. The flexible mid region allows the LED lamp head to be moved into a position where illumination is desired.

Referring now to FIG. **1** a flexible light emitting diode (LED) lamp **100** is illustrated. The flexible LED lamp **100** may also be referred to as a flexible LED light or a gooseneck LED lamp. The flexible LED lamp **100** uses no light bulb that can burn out and has no fragile bulb that may break and need replacing. The lighting provided by the flexible LED lamp **100** through its light emitting diodes or similar optoelectronic devices, is a cool light because it is efficient and need not heat a filament used in light-bulbs. The color of light generated by the flexible LED lamp can be factory programmed in one embodiment or user selectable to the color settings of red, amber, green, blue, and white or combinations thereof in another embodiment. The flexible LED lamp **100** utilizes sold-state technology including electrical to optical converters (i.e., light emitting diodes (LEDs)) in order to provide energy efficiency.

The flexible LED lamp **100** includes a base **102**, a flexible mid region **104**, and an LED lamp head **106**. The base **102** may also be referred to as a power pack, battery pack, lamp support member or pedestal base. The flexible mid region **104** may also be referred to as a gooseneck, a flexible neck, a flexible tube, a flexible pipe, a flexible support member, or a flexible extension. The LED lamp head **106** may also be referred to as LED light head, or LED bulb head, and because it is detachable from the flexible mid region **104**, it may also be referred to as a detachable LED lamp head, pluggable LED lamp head, a removable LED lamp head, or a variation thereof.

The LED lamp head **106** includes a receptacle to receive a plug at the end of the flexible mid region **104**. Alternatively, the LED lamp head **106** may include a plug and the flexible mid region **104** may include a receptacle at an end to receive the plug of the LED lamp head **106**.

The base **102** includes a housing **110**, a battery ON/OFF switch **112**, a regulator, and a clip or clamp **114**. The housing **110** includes an upper half housing **110**A and a lower half housing **110**B. The battery ON/OFF switch **112** switches the power supplied by the one or more batteries to the electron-

ics of the LED lamp head **106** on and off. Energy of the one or more batteries can be conserved by decoupling the one or more batteries from the control electronics in the LED lamp head **106**. The regulator (functional block shown in FIG. **10**) regulates the power to proper voltage (including a step down in voltage in one embodiment) and current levels for the LED lamp head **106**.

The clip or clamp **114** allows the base to couple to objects such as a music stand, table, book case, or other objects. The object is held between the upper-half housing **110**A and the clip or clamp **114**. Other bases, clips or clamps used for lamps or lights found in the prior art can be used to provide support and coupling to objects such as those found in U.S. Pat. Nos. 1,010,335; 1,340,108; 1,692,394; 1,735,212; 1,790,500; 3,111,277; 3,381,122; 3,543,017; 3,666,938; 4,449,171; 4,432,042; 4,796,162; 4,965,708; 4,605,990; 5,172,974; 5,268,826; 5,879,075; and 5,944,407 for example.

The housing **110** of the base **102**, including the upper half housing **110**A and the lower half housing **110**B, in one embodiment is molded out of plastic. In another embodiment, the housing **110** of the base **102** may be formed out of a metal.

The flexible mid region **104** includes a threaded end **120**, a flexible center **122**, and a connector end **124**. The threaded end **120** and the flexible center **122** are hollow to allow one or more electrical cables or wires to couple between the base **102** and the connector end **124**. The one or more electrical cables or wires may carry power from the base **102** to the connector end **124**. A connector of the lamp head **106** can couple to the connector end **124** in order to receive power.

The flexible center **122** is shaped as a flexible hollow cylinder and can be formed out of a flexible metal tube, a flexible plastic tube, or constructed as found in the prior art such as found in U.S. Pat. Nos. 1,692,394; 1,790,500; 3,582,536; 5,172,974; 5,521,803; 5,687,774; and 5,944,407 for example. In one embodiment, the flexible center **122** is a flexible hollow tube having a circular cylinder shape. In another embodiment, the flexible center **122** is a hollow tube having a rectangular cylinder shape.

The connector end **124** allows the LED lamp head **106** to be exchanged for another, if a different single-color LED lamp head is desired, or if a variable or multi-color LED lamp head is desired.

Other flexible mechanisms for lamps or lights found in the prior art can be used for the flexible mid region **104** such as flexible arms, movable joints, telescopic or extendable (i.e. expandable or slideable) and/or rotatable tubes such as found in U.S. Pat. Nos. 1,010,335; 1,340,108; 1,735,212; 3,381,122; 3,543,017; 4,449,171; 4,432,042; 4,796,162; and 4,965,708 for example.

The LED lamp head **106** includes a lamp housing **130**, a lens **132**, and an intensity/ON/OFF switch **134**. For a multicolor lamp head, an optional color switch **136** can be further included as part of the LED lamp head **106** to allow a change of colors in the light output. If a single color is desirable, the optional color switch **136** need not be used.

The LED lamp head **106** and the lamp housing **130** may be shaped similar to a snake's head as illustrated. The lamp housing **130** includes an upper half lamp housing **130**A and a lower half lamp housing **130**B. The lamp housing **130** is hollow and provides support for a printed circuit board (not shown in FIG. **1**). The lamp housing **130** includes an engagement portion **131** to provide sufficient support for the lamp head **106** when coupled to the flexible mid region **104**. The lamp housing **130** includes a lens opening to hold the lens **132**, button openings (**404** and **408** shown in FIG. **4**) to allow buttons or rotating elements to extend therefrom (including buttons/rotating elements of the intensity/ON/OFF switch **134** and the optional color switch **136** to switch or change their settings), and a connector opening to allow the connector end **124** to couple to a connector of the LED lamp head **106**.

The lens **132** couples into the lens opening of the lamp housing **130** to collimate and disperse or diffuse the light generated by the LED lamp head **106**. The intensity/ON/OFF switch **134** can be a pushbutton switch which changes from ON high to ON low to OFF in sequence. The optional color switch **136** can be a pushbutton switch that varies the color or hue of the light generated by the LEDs in the case of a multi-color LED lamp head **106**.

The LED lamp head **106** can be a single color LED lamp head or a multicolor LED lamp head. A single color LED lamp head can provide a single color of light formed out of the primary colors red, green or blue. A multi-color LED lamp head can provide variations in color of the light output from proportionally combining the primary colors red, green or blue. Additionally, white LEDs may be utilized in order that the LED lamp head **106** provide a white light output. Alternatively, a combination of red, green and blue LEDs can be used in order to generate a white light output from the LED lamp head **106**.

The dimensions of the flexible LED lamp **100** may be relatively small such that it is compact and very portable. The dimensions of housing **130** of the LED lamp head **106** may be about three inches long, one and one-quarter inches in height, and one and three-quarter inches wide for example. The length of the flexible mid region **104** can be about twenty inches for example. The base **103** can be about four and one half inches long, two inches wide and three-fourths of an inch high for example.

Referring now to FIG. **2**, the flexible LED lamp **100** is illustrated with the LED lamp head **106** positioned differently to show the flexibility in the flexible mid region **104**. FIG. **2** more clearly illustrates a top of the upper half lamp housing **130**A.

Referring now to FIG. **3**A, a disassembled view of the flexible LED lamp **100** is illustrated. FIG. **3**A also illustrates an exploded view of the base **102** and the internal components that it may include. The base **102**, illustrated in FIG. **3**A, includes the upper half housing **110**A, the lower half housing **110**B, the battery ON/OFF switch **112**, the clip or clamp **114**, a threaded nut **310**, one or more batteries **311**, a battery connector plate **312**, a pressure plate **313**, a washer **314**, a threaded nut **315**, a first opening **316** in the housing **110**, and a second opening **317** in the housing **110**. One or more wires coupling the battery connector plate **312** to the battery ON/OFF switch **112** are not illustrated.

After the threaded end **120** is inserted into the opening **316**, the threaded nut **310** can be screwed onto the threads of the threaded end **120** and tightened to couple the flexible mid region **104** to the base **102**. Any wires, such as one or more wires **320**, extending from flexible mid region **104** out of the threaded end **120** can be coupled to the battery ON/OFF switch **112**, the battery connector plate **312**, or other electrical component as may be needed.

The battery ON/OFF switch **112** can have its button, toggle or actuator portion inserted into the opening **317** so that a threaded portion just extends out beyond the housing **110** and the washer **314** and the nut **315** can be coupled to the extending threaded portion, thereby coupling the battery ON/OFF switch **112** to the base **102**.

The flexible mid region **104** includes the threaded end **120**, the flexible center **122**, the connector end **124**, and the one or more wires or cables **320** extending out from the threaded end **120**. The one or more wires or cables **320** are for coupling to the electrical components in the base **102** at one end and the connector end **124** at an opposite end. The one or more wire cables **320** are routed within the hollow portion of the flexible mid region **104** from the connector end **124** and out through the threaded end **120**.

FIG. **3**A illustrates the LED lamp head **106** including the lamp housing **130** (upper half **130**A and lower half **130**B), the intensity/ON/OFF switch **134**, the optional color switch **136**, and a connector **330** at the engagement portion **131** of the lamp housing **130**. Lens **132** of the LED lamp head **106** is not shown in FIG. **3**A. The connector **330** is to receive the connector end **124** of the flexible mid region **104** in order to mechanically support the LED lamp head **106** and provide power to the electronic components contained therein. The LED lamp head **106** is preferably made as light as possible to avoid undue forces on the connector **330** and the connector end **124** of flexible mid region **104**. The lamp housing **130**, including the upper half **130**A and the lower half **130**B, are made of plastic to form a hollow plastic housing in one embodiment.

Referring now to FIG. **3**B, a disassembled view of a flexible LED lamp **100**' is illustrated. The flexible LED lamp **100**' also illustrates exploded views of an alternate base **102**' and the internal components that it may contain, and the LED lamp head **106** and the internal components the LED lamp head may contain.

The alternate base **102**', illustrated in FIG. **3**B, includes the upper half housing **110**A, the lower half housing **110**B, a battery ON/OFF slider switch **112**', the clip or clamp **114**, the threaded nut **310**, the one or more batteries **311**, the first opening **316** in the housing **110**, the second opening **317** in the housing **110**, and a base electrical subassembly **318**. The base electrical subassembly **318** includes a printed circuit board **340**, the battery ON/OFF slider switch **112**' coupled thereto, and a pair of battery connectors **342** to couple to terminals of the one or more batteries **311**. The printed circuit board **340** further includes wire traces (not illustrated) to couple between the battery connectors **342**, the switch **112**', and terminals to couple to the one or more wires **320** of the flexible mid region **104**. As the electrical subassembly is mounted into the upper half housing **100**A, a slider tab **319** of the switch **112**' is inserted into the opening **317** from the inside of the housing **110** to extend through and allow user access to it. A user can actuate the switch **112**' by moving the slider tab **319** back and forth. Other types of switches may be also used for the battery ON/OFF switch **112**, including toggle switches and push button switches. The slider switch **112**' couples well to the printed circuit board **340** to provide an integrated electrical subassembly **318**.

In FIG. **3**B, the LED lamp head **106** includes the lamp housing **130** (upper half **130**A and lower half **130**B), the lens **132**, a button **334** for the intensity/ON/OFF switch **134**, an optional button **335** for the optional color switch **136** (for the multicolor lamp head), and a lamp electrical subassembly **336**.

The lamp electrical subassembly **336** includes the connector **330** for coupling to the connector end **124** of the flexible mid region **104**, a printed circuit board **337**, and one or more electrical-to-optical (EO) converters **339** to generate a light source. The lamp electrical subassembly **336** is further described below with reference to FIG. **4**. As previously described, the lamp housing **130** is molded out of plastic in one embodiment.

The one or more electrical-to-optical converters **339** are optoelectronic devices which convert electrical energy (voltage/current) into optical energy (light/photons), such as light emitting diodes or laser diodes. That is, the one or more electrical-to-optical (EO) converters **339** are transducers which convert electrons of an electrical signal into a light source or photons of an optical signal. Light emitting diodes (LEDs) emitting light in the visible spectrum are preferably used as the one or more electrical-to-optical converters **339**.

In one embodiment, six LEDs are used (one red, two blue, and three green) to allow the varying colors to be generated in a multicolor lamp head. The current to each of the red, green, and blue LEDs can be individually varied to select a mixture of primary colors to generate the color of light. In another embodiment, five LEDs are used of the same color (five red, five blue, five green, or five white) to generate light of one color for a single color lamp head. In yet another embodiment, five LEDs (one red, two blue, and three green) are used with a factory set intensity of each in order to generate white light.

The base **102** and the base **102**' illustrated in FIGS. **3**A–**3**B respectively, may also include an opening in its housing **110**, and a connector for a DC line power plug in order to power the flexible LED lamp **100** (not shown in FIGS. **3**A–**3**B). The one or more batteries **311** may be rechargeable batteries that can be recharged by the DC line power. The DC line power can be generated by using a transformer and rectifier coupled to AC line power.

Referring now to FIG. **4**, a magnified exploded view of the LED lamp head **106** and a magnified portion of the flexible mid region **104** are illustrated. The lower-half lamp housing **130**B includes a lens opening **402** at a bottom region, a button opening **404** in a bottom region of the engagement portion **131**, and a connector opening **406** in a back region of the engagement portion **131**. The upper-half lamp housing **130**A includes a button opening **408** in a top region. The upper-half lamp housing **130**A further includes a first locking tab **410** at a front region and a second locking tab **412** at a back region extending from inside the upper-half lamp housing **130**A to couple to a front slot and a back slot in the lower-half lamp housing **130**B. The locking tabs **410**, **412** and slots couple together to hold the upper-half lamp housing **130**A and the lower-half lamp housing **130**B together as the lamp housing **130**. The upper-half lamp housing **130**A also includes one or more press tabs **414** to press down on the printed circuit board **337** of the lamp electrical subassembly **336**.

In one embodiment, the buttons **334** and **335** are clear plastic such that light generated inside the lamp head **104** can be directed through them to illuminate the location of the buttons. This allows a user to locate and adjust the lighting in dark conditions.

The lamp electrical subassembly **336** includes the connector **330** for coupling to the connector end **124** of the flexible mid region **104**, the printed circuit board **337**, and the one or more electrical-to-optical (EO) converters **339**. The one or more EO converters **339** and the connector **330** are coupled to the printed circuit board **337**. In one embodiment, the one or more EO converters **339** are arranged around a circle having a center that aligns with the optical axis of the lens **132**. Each optical axis of the one or more EO converters may be spaced apart equally around the circle with the same distance from the center of the circle. The optical axis of each EO converter **339** points into the lens **132** when the LED lamp head is assembled together.

"The connector **330** fits into the engagement region **131** of the lower half lamp housing **130**B. In one embodiment, the connector **330** and the connector end **124** are standard barrel connectors either of which can be female (a "barrel jack") or male (a "barrel plug") respectively in order to couple together. The connector **330** and the connector end **124** allow the LED lamp head to plug and unplug from the flexible mid region **104** and the lamp. Thus, one lamp head can easily be replaced with another lamp head. Furthermore with standard barrel connectors being used as the connector **330** and the connector end **124**, the lamp head can swivel on the end of the flexible mid region **104**. Thus, the lamp head has a large range of motion with respect to the base. "

Referring now to FIG. **5**A, a top view of the lower-half lamp housing **130**B is illustrated. The lower-half lamp housing **130**B further includes a pair of front printed circuit board (PCB) rests **502**, a pair of rear PCB rests **504**, a rear PCB guide tab **505**, and a pair of side PCB guide tabs **506**. The front PCB rests **502** include a cutout into which the printed circuit board **337** of the lamp electrical subassembly **336** fits which keeps it from moving forward when coupled to the connector **330** couples to the connector end **124** of the flexible mid region **104**. The rear PCB rests **504** also include a pair of cutouts into which the printed circuit board **337** of the lamp electrical subassembly **336** fits which keeps it from moving sideways and the connector **330** aligned with the opening **406**. An edge of the rear PCB guide tab **505** rises to the level of the PCB **337** to confine a rear edge of the PCB **337** and keep it from moving backward when the lamp head is disconnected and the connector **330** is uncoupled from the connector end **124** of the flexible mid region **104**. Edges of the side PCB guide tabs **506** also rise to the level of the PCB **337** to confine its side edges and keep the PCB **337** from moving sideways in the lamp housing **130**.

The lower-half lamp housing **130**B further includes a front groove or slot **508** and a rear groove or slot **509** to couple to the locking tabs **410** and **412** respectively and hold the upper-half lamp housing **130**A and the lower-half lamp housing **130**B coupled together. A hook in each of the locking tabs **410** and **412** mates into the grooves or slots **508** and **509** respectively. The locking tabs **410** and **412** can be flexed to disassemble the LED lamp head **106** and repair or replace components if needed.

Referring now to FIG. **5**B, a top perspective view of the upper-half lamp housing **130**A is illustrated. The upper-half lamp housing **130**A includes the button opening **408**, the first locking tab **410**, the second locking tab **412**, and the one or more press tabs **414**. The locking tabs **410**, **412** couple to the grooves or slots **508**, **509** respectively to hold together the upper-half lamp housing **130**A and the lower-half lamp housing **130**B together as the lamp housing **130**. The one or more press tabs **414** press down on the printed circuit board **337** of the lamp electrical subassembly **336** to hold its position within the pair of front printed circuit board (PCB) rests **502**, the pair of rear PCB rests **504**, the back PCB guide tab **505**, and the pair of side PCB guide tabs **506** of the lower half housing **130**B.

Referring now to FIG. **6**, a magnified exploded view of the base **102**' and a magnified portion of the flexible mid region **104** are illustrated.

The base **102**' includes the upper half housing **110**A, the lower half housing **110**B, the battery ON/OFF slider switch **112**', the clip or clamp **114**, the threaded nut **310**, the one or more batteries **311**, the first opening **316** in the housing **110**, the second opening **317** in the housing **110**, and the base electrical subassembly **318**. The base electrical subassembly **318** includes the switch **112**' and a pair of battery connectors **342** coupled to the printed circuit board **340**. In one embodiment, the one or more batteries **311** is a nine volt battery with positive and negative terminals **602** to couple to the pair of battery connectors **342**. The clip or clamp **114** includes a screw mount **602** through which a screw can couple the clip to the upper-half housing **110**A and act as a pivot point. The clip or clamp **114** may include a pivot stop **604** which can also include a spring to push the clip or clamp **114** near one end to lever the opposite end into an object and squeeze it against the upper-half housing **110**A.

The one or more wires **320** of the flexible mid region **104** may couple to terminals of the printed circuit board **340** or directly to terminals of the switch **112**'. The threaded end **120** of the flexible mid region **104** includes threads **604** to couple to the threads of the nut **310** and hold the flexible mid region **104** and the housing **102**' coupled together.

Referring now to FIGS. **7**A–**7**B, magnified views of the lens **132** are illustrated. The lens **132** press fits into the lens opening **402** of the lower-half lamp housing **130**B of the LED lamp head **106**. An epoxy or glue may be used around the edges of the lens **132** and the opening **402** to further hold it in place. The lens **132** may be formed out of polycarbonate, plastic, acrylic, glass, or other materials that can collimate, focus, disperse or diffuse visible wavelengths of light generated by the one or more electrical to optical converters **339**.

FIG. **7**A illustrates a magnified cross section of the lens **132**. In one embodiment, the lens **132** is a circular collimating and diffusing lens to form a uniform light output. The lens **132** includes a top optical surface **700** and a bottom convex diffusing surface **702**. Incident light **704** from the electrical to optical converters (i.e., LEDs) **339** enters the lens through the top optical surface **700**, is collimated, focused and spread or dispersed outward, exiting through the bottom convex diffusing surface **702**, as illustrated by the light rays **706**. The convex diffusing surface **702** is a convex surface which is bead blasted to provide a pitted surface to further diffuse the light and spread it outward. The optical surface **700** is a relatively flat surface which is polished to an optical grade so that light can effectively enter and be focused by the lens **132** outward with little reflection.

In the case of color LEDs, the lens **132** diffuses or blends the individual colors into a single color output. In one case, incident light from red LEDs, green LEDs, and blue LEDs may be diffused together by the lens **132** into a single white color output light.

The lens **132** has a number of dimensions to collimate, focus and disperse light, as well as to mechanically couple into the lens opening **402** in the lower-half lamp housing **130**B. The lens **132** has a first diameter D**1** and a second diameter D**2**. The lens **132** further has a first side thickness T**1** and a second side thickness T**2**. The approximate dimensions of these parameters are 0.543 inches for D**1**, 0.547 inches for D**2**, 0.037 inches for T**1**, and 0.075 inches for T**2**. The curvature of the convex diffusing surface **702** has an arc radius of approximately 0.75 radians.

FIG. **7**B is a magnified view of the lens **132** from the bottom. The first diameter D**1** forms a cylinder C**1** while the second diameter D**2** forms a cylinder C**2** in the lens **132**. The cylinder C**1** mates into the opening **402** while the larger cylinder C**2** keeps the lens **132** from being pushed into the lower-half lamp housing **130**B. A glue, epoxy or other adhesive can be further used around the edge of the lens **132** and the opening **402** to hold them coupled together.

Referring now to FIG. **8**A, a view of the bottom side of the printed circuit board **337** of the lamp electronic subas-

sembly **336** is illustrated. The first side includes the intensity/ON/OFF switch **134**, the connector **330**, the one or more electrical-to-optical (EO) converters (i.e. LEDs) **339**, and an electrical-to-optical (EO) controller **802**.

The EO controller **802** is coupled to the one or more EO converters **339**, the intensity/ON/OFF switch **134**, and the connector **330**. The EO controller **802** receives power from the one or more batteries **311** through the connector **330**, if the battery ON/OFF switch **112** is switched ON. The EO controller **802** controls the amount of power provided to the EO converters **339** and thereby can control the light intensity as well as the color, if different color EO converters **339** are utilized.

Referring now to FIG. **8**B, a view of the top side of the printed circuit board **337** of the lamp electronic subassembly **336** is illustrated. The second side includes the optional color switch **136** which couples to the EO controller **802** through traces **804**. A user switches the optional color switch **136** which is communicated to the EO controller **802** to select a desired color.

Referring now to FIG. **9**, a side view of the lamp electronic subassembly **336** is illustrated in alignment with the lens **132**, as they are to be positioned in the LED lamp head **106**. In order to efficiently generate light, the one or more electrical-to-optical converters (EOs) **339** are aligned with the lens **132**. Preferably they are aligned nearer the central optical axis of lens **132**.

The connector **330** plugs onto the flexible mid region **104** of the flexible LED lamp **100**, so the LED lamp head **106** can receive power. A user controls the color and the light intensity of the light generated by the one or more EO converters **339** by using the switches **134** and **136**. The EO controller **802** receives input information from the user and causes the one or more EO converters (i.e., LEDs) **339** to generate photons forming the incident light source **704** onto the lens **132**. The lens **132** receives the incident light source **704** and focuses and diffuses the light into the output light rays **706**.

Referring now to FIG. **10**, a block diagram of the system **1000**, including the electronic and optoelectronic components utilized in the flexible LED lamp **100**, is illustrated. FIG. **10** also illustrates external components that may be used with the flexible LED lamp **100**. The external components include a DC power plug **1004**, a power cable **1005**, and a transformer/rectifier **1006**. In one embodiment, the components of the system **1000** include the one or more batteries **311**, the battery ON/OFF switch **112**, and the regulator **1003** of the base **102**; the one or more wires **320** and connector end **124** of the flexible mid region **104**; and the connector **330**, the intensity/ON/OFF switch **134**, the one or more EO converters **339**, and the lens **132** of the LED lamp head **106**. In another embodiment, the system **1000** further includes the optional color switch **136** to support a multicolor LED lamp head.

In yet another embodiment of the system **1000**, the base **102** further includes a DC power connector **1002** to receive power from an external DC source provided by the external components **1004–1006**. Instead of using battery power from the one or more batteries **311**, line power can be used from an external power source. In this case, an external DC power source (derived from line power) can be used to power the EO converters **339** and/or recharge one or more rechargeable batteries that may be utilized in the flexible LED lamp **100**. The transformer/rectifier **1006** converts an AC power supply into desired DC power supply voltages on the power cable **1005** for the electronic components and electro-optic components (i.e., electrical-to-optical controllers **339**) of the flexible LED lamp **100**, **100'**. The DC power provided by the transformer/rectifier **1006** can be a low voltage power supply such as 9 volts.

The one or more batteries **311** couples to the battery ON/OFF switch **112**. The battery ON/OFF switch **112** couples to the regulator **1003** which regulates the power to proper voltage and current levels for the LED lamp head **106**. The regulator **1003** couples to the one or more wires **320** in the flexible mid region **104**. The connector end **124** is coupled to the one or more wires **320** to receive power from the one or more batteries **311** regulated by the regulator **1003**, if the switch **112** is turned ON. The connector **330** of the LED lamp head **106**, plugs onto the connector end **124** so power can be coupled to the EO controller **802**. The intensity/ON/OFF switch **134** is coupled to the EO controller **802** to allow a user to signal the EO controller **802** as to the desired intensity of light and whether the lamp should be turned ON or OFF. The optional switch **136** couples to the EO controller **802** to allow a user to signal the EO controller **802**, what color is desired, if a multicolor LED lamp head is provided with multiple colors of EO converters **339**. The one or more EO converters **339** couple to the EO controller **802** to be controlled as to whether or not they are turned ON or OFF in generating light/photons. The light source **704** generated by the one or more EO converters **339** is coupled into the lens **132** to generate the diffused output light source **706**.

The battery on/off switch **112** powers the electronic and electro-optic components of the flexible LED lamp **100** on and off. No current is utilized by components with the battery ON/OFF switch **112** switched to the OFF position. The battery ON/OFF switch **112** can be a push button switch, a turn-able knob or a sliding switch.

The optional switch **136** in one embodiment functions so that a user can select the color, hint or hue of the light that is desired. In another embodiment, the optional switch **136** may function so that a user can select the intensity or brightness of light that is desired. In another yet embodiment, the optional switch **136** is not provided and the flexible LED lamp **100** has its color and light intensity factory programmed with little user selectivity.

In one embodiment, the color of lighting provided by the linear LED light can be selected by varying the mixture of light generated by red, green, and blue light emitting diodes (LEDs). In an alternate embodiment, the intensity or brightness of the light can also be smoothly varied by varying the current to the light emitting diodes over a range. The current can be varied by proportional amounts to maintain the same color. In yet another alternate embodiment, the intensity or brightness of the light can also be varied at set levels by completely turning ON or OFF one or more light emitting diodes of a same color. The intensity/ON/OFF switch **134** can be used to select a high intensity ON light, a low intensity ON light, and an OFF condition with no light. With the battery ON/OFF switch **112** in the ON position, the EO controller **802** remains powered on to receive inputs from the intensity/ON/OFF switch **134** and optionally switch **136** when selected by a user.

The EO controller **802** receives power through the one or more wires **320** in the flexible mid region **104**. It also controls the amount of light output and optionally the color generated by the one or more EO converters, in response to user inputs from the switches **134** and **136**. In one embodiment, the EO controller **802** varies the number of electrical-to-optical converters (EOs) **339** that are turned ON

in order to change the light intensity in response to inputs from the intensity/ON/OFF switch **134**. In another embodiment, the EO controller varies the number of color EO converters **339** that are turned ON and OFF in order that their combination generates the desired color, in response to the optional color switch **136**. Alternatively, the EO controller **802** may vary the current supplied to the EO converters **339** in order to control the light intensity and/or the color of light generated.

The flexible LED lamp **100** utilizes solid-state technology. Because it does not use glass bulbs, the flexible LED lamp **100** can withstand harsh treatment from transporting equipment to which its attached from one place to another. The flexible LED lamp **100** does not have a light-bulb that will burn out nor does it generate any significant level of heat, such that it would become warm. The flexible LED lamp can be illuminated in one embodiment to one of any six colors allowing a performer to choose the color to match an aura of a performance or the stage or atmosphere of a club.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those ordinarily skilled in the art after reading the disclosure. Rather, the invention should be construed according to the claims that follow below.

What is claimed is:

1. A flexible lamp comprising:

a base, wherein the base is a power pack and includes a regulator, and a battery on/off switch;

a flexible mid region coupled at a first end to the base;

a lamp head coupled to a second end of the flexible mid region, the lamp head including

one or more electrical-to-optical converters to generate a light source, and

a lens to spread the light source out from the lamp head; and

the flexible mid region to adjust a location of the lamp head.

2. The flexible lamp of claim **1**, wherein

the flexible mid region is a goose neck, a flexible neck, a flexible pipe, or a flexible tube.

3. The flexible lamp of claim **1**, wherein the power pack further includes one or more batteries.

4. The flexible lamp of claim **1**, wherein the power pack further includes a clip or clamp to couple to an object.

5. The flexible lamp of claim **1**, wherein

the lens further to diffuse the light source generated by the one or more electrical-to-optical converters.

6. The flexible lamp of claim **1**, wherein

the one or more electrical-to-optical converters include at least one electrical-to-optical converter to generate a red light source, at least one electrical-to-optical converter to generate a green light source, and at least one electrical-to-optical converter to generate a blue light source, and

the lens further to diffuse the red light source, blue light source, and green light source into a single color of an output light source from the lamp head.

7. The flexible lamp of claim **6**, wherein the single color of the output light source from the lamp head is white.

8. The flexible lamp of claim **1**, wherein

the lamp head further includes an on/off switch to switch on and off the one or more electrical-to-optical converters.

9. A flexible lamp comprising:

a base, wherein the base includes an on/off switch;

a flexible mid region coupled at a first end to the base;

a lamp head coupled to a second end of the flexible mid region, the lamp head including

one or more electrical-to-optical converters to generate a light source, and

a lens to spread the light source out from the lamp head; and

the flexible mid region to adjust a location of the lamp head and includes one or more wires coupled between the lamp head and the base to provide power thereto.

10. The flexible lamp of claim **9**, wherein

the lamp head further includes an on/off switch to switch on and off the one or more electrical-to-optical converters.

11. The flexible lamp of claim **10**, wherein the lamp head further includes

a color switch to select the color of the light source generated by the one or more electrical-to-optical converters.

12. The flexible lamp of claim **9**, wherein

the one or more electrical-to-optical converters are light emitting diodes (LEDs).

13. The flexible lamp of claim **9**, wherein

the lamp head further includes

a connector for coupling to a connector end of the flexible mid region.

14. The flexible lamp of claim **9**, wherein

the flexible mid region further includes a barrel jack, and,

the lamp head further includes is a barrel plug to plug into the barrel jack and to unplug from the barrel jack to replace the lamp head.

15. The flexible lamp of claim **14**, wherein

the lamp head to swivel on the flexible mid region when the barrel plug is plugged into the barrel jack.

16. The flexible lamp of claim **9**, wherein

the lens is made of polycarbonate, acrylic, glass or plastic.

17. The flexible lamp of claim **9**, wherein

the lens includes a polished flat surface on one side to receive the light source and a curved surface on an opposite side to diffuse the light source.

18. The flexible lamp of claim **17**, wherein

the curved surface of the lens has a bead blasted surface to further diffuse the light source.

19. The flexible lamp of claim **9**, wherein

the light source is coupled into the lens and radiated outward therefrom without the use of a fragile glass bulb or filament.

20. The flexible lamp of claim **9**, wherein

the lamp head further includes

a printed circuit board with an electrical-to-optical controller to control the one or more electrical-to-optical converters; and

an on/off switch to switch the generation of light by the one or more electrical-to-optical converters on and off.

21. The flexible lamp of claim **20**, wherein the lamp head further includes

an intensity selection switch to vary the brightness of the generated light.

22. The flexible lamp of claim **20**, wherein the lamp head further includes

a color selection switch to selectively choose the mixture of primary colors generated by the one or more

electrical-to-optical converters to vary the color of the generated light.

23. The flexible lamp of claim **9**, further comprising:

a transformer to transform AC power to a safe efficient power to power the one or more electrical-to-optical optical converters in an efficient manner.

24. A flexible lamp comprising:

a support means;

a flexible means coupled at a first end to the support means;

a lamp support means coupled to a second end of the flexible means, the lamp support means including

one or more light emitting diodes (LEDs) to generate a light source, and

a diffusion means to spread the light source out from the lamp support means; and

wherein the support means is a power means and includes an on/off switching means to switch the light source on or off and the flexible means to adjust a location of the lamp support means.

25. The flexible lamp of claim **24**, wherein

the lamp head includes a connector for coupling to a connector end of the flexible mid region.

26. The flexible lamp of claim **24**, wherein

the diffusion means is a lens formed out of polycarbonate, acrylic, glass or plastic.

27. The flexible lamp of claim **24**, wherein

the flexible means is a goose neck, a flexible neck, a flexible pipe, or a flexible tube.

28. The flexible lamp of claim **24**, wherein the power means further to couple to line power.

29. The flexible lamp of claim **24**, wherein

the power means further includes

one or more batteries.

30. The flexible lamp of claim **24**, wherein

the power means further includes

a regulation means to regulate voltage and current to the lamp head.

31. A flexible lamp comprising:

a support means, wherein the support means includes a clipping means or a clamp means to couple to an object;

a flexible means coupled at a first end to the support means;

a lamp support means coupled to a second end of the flexible means, the lamp support means including

one or more light emitting diodes (LEDs) to generate a light source, and

a diffusion means to spread the light source out from the lamp support means; and

the flexible means to adjust a location of the lamp support means.

32. A method of forming a flexible lamp, the method comprising:

providing a base including an on/off switch;

coupling a flexible tube to the base at a first end;

forming an LED lamp head including one or more light emitting diodes, the on/off switch of the base to turn on and turn off power to the one or more light emitting diodes; and

coupling the LED lamp head to a second end of the flexible tube.

33. The method of claim **32**, wherein,

the base further includes a regulator to regulate voltage and current to the LED lamp head.

34. The method of claim **32**, wherein,

the flexible lamp is portable and

the base is a power pack to include one or more batteries to provide power to the one or more light emitting diodes.

35. The method of claim **32**, wherein,

the forming of the LED lamp head includes forming a lens to diffuse a light source generated by the one or more light emitting diodes.

36. The method of claim **35**, wherein,

the lens is transparent and formed out of polycarbonate, acrylic, plastic, or glass.

37. The method of claim **35**, wherein,

the forming of the lens includes

bead blasting a curved surface to diffuse the light source.

38. A flexible LED light comprising:

a base;

an LED lamp head including

one or more light emitting diodes (LEDs) to generate light, and

a lens to spread the light generated by the one or more light emitting diodes (LEDs) out from the LED lamp head;

a flexible mid region coupled to the base and to couple to the LED lamp head, the flexible mid region being movable to adjust a location of the LED lamp head coupled thereto; and

wherein the base is a power pack and includes a regulator to regulate voltage and current to the LED lamp head, and a battery on/off switch.

39. The flexible LED light of claim **38**, wherein

the flexible mid region is a goose neck, a flexible neck, a flexible pipe, or a flexible tube.

40. The flexible LED light of claim **38**, wherein

the power pack further includes one or more batteries.

41. The flexible LED light of claim **40**, wherein

the power pack further includes a clip or clamp to couple to an object.

42. A flexible LED light comprising:

a base including an on/off switch;

an LED lamp head including

one or more light emitting diodes (LEDs) to generate light, and

a lens to spread the light generated by the one or more light emitting diodes (LEDs) out from the LED lamp head; and,

a flexible mid region coupled to the base and to couple to the LED lamp head, the flexible mid region being movable to adjust a location of the LED lamp head coupled thereto, the flexible mid region including one or more wires coupled between the LED lamp head and the base to provide power thereto.

43. The flexible LED light of claim **42**, wherein

the LED lamp head further includes an on/off switch, and

one or more wires coupled to the LED lamp head to provide power thereto.

44. The flexible LED light of claim **43**, wherein

the lamp head further includes a color switch to select the color of the light source generated by the one or more electrical-to-Optical converters.

45. The flexible LED light of claim **42**, wherein

the LED lamp head further includes an on/off switch, and

the base further includes one or more batteries to provide power thereto.

46. The flexible LED light of claim **42**, wherein

the lamp head further includes a color switch to select the color of the light source generated by the one or more electrical-to-optical converters.

47. The flexible LED light of claim **42**, wherein

the one or more light emitting diodes (LEDs) are a plurality of light emitting diodes (LEDs) to generate one or more colors of light in the light source.

48. The flexible LED light of claim **47**, wherein

the plurality of light emitting diodes (LEDs) generate a plurality of colors of light and

the LED lamp head further includes

a color switch to select one shade of the plurality of colors of light for the plurality of light emitting diodes (LEDs) to generate.

49. The flexible LED light of claim **48**, wherein

the LED lamp head further includes

an electrical to optical (EO) controller coupled to the color switch to control the plurality of light emitting diodes (LEDs) to generate the selected shade of color of light.

50. The flexible LED light of claim **42**, wherein

the LED lamp head is detachable and includes a connector for coupling to a connector end of the flexible mid region.

51. The flexible LED light of claim **42**, wherein

the lens is made of polycarbonate, acrylic, glass or plastic.

52. The flexible LED light of claim **42**, wherein

the lens includes a polished flat surface on one side to receive the light source and a curved surface on an opposite side to diffuse the light source.

53. The flexible LED light of claim **52**, wherein

the curved surface of the lens has a bead blasted surface to further diffuse the light source.

54. The flexible LED light of claim **42**, wherein

the LED lamp head further includes

an ON/OFF switch to selectively turn on and off the plurality of light emitting diodes (LEDs) to select a desired intensity of light.

55. The flexible LED light of claim **54**, wherein

the LED lamp head further includes

an electrical to optical (EO) controller coupled to the ON/OFF switch to control the plurality of light emitting diodes (LEDs) to generate the selected intensity of light.

56. The flexible LED light of claim **42**, wherein

the light generated by the one or more light emitting diodes (LEDs) is coupled into the lens and radiated outward therefrom without the use of a fragile glass bulb or filament.

57. A flexible LED lamp comprising:

a lamp head including

one or more light emitting diodes to generate one or more light sources,

a lens to receive the one or more light sources and to diffuse the one or more light sources into a single output light from the lamp head,

a user selector switch to select the single output light from the lamp head,

a barrel plug to couple the lamp head to the flexible lamp and to receive power;

a base including an on/off switch, a clip, and one or more batteries to selectively couple power to the lamp head, the on/off switch to selectively couple power to the lamp head, the clip to couple the flexible lamp to an object; and

a gooseneck coupled to the base, the gooseneck to adjust a location of the lamp head, the gooseneck including one or more wires and a barrel jack, the one or more wires to couple power from the base to the barrel jack, the barrel jack to couple to the barrel plug of the lamp head.

58. The flexible LED lamp of claim **57**, wherein

the base further to couple to an external power source to selectively couple power to the lamp head.

59. The flexible LED lamp of claim **57**, wherein

the one or more light emitting diodes include at least one light emitting diode to generate a red light source, at least one light emitting diode to generate a green light source, and at least one light emitting diode to generate a blue light source, and

the lens to diffuse the red light source, blue light source, and green light source into a single color of the single output light from the lamp head.

60. The flexible LED lamp of claim **59**, wherein

the single color of the output light source from the lamp head is white.

61. The flexible LED lamp of claim **57**, wherein

the user selector switch to select the color of the single output light from the lamp head.

62. The flexible LED lamp of claim **57**, wherein

the user selector to select the intensity of the single output light from the lamp head.

63. The flexible LED lamp of claim **57**, wherein

the lens includes a polished flat surface on one side to receive the one or more light sources and a curved surface on an opposite side to diffuse the one or more light sources into the single output light.

64. The flexible LED lamp of claim **63**, wherein

the curved surface of the lens has a bead blasted surface to further diffuse the one or more light sources.

65. The flexible LED lamp of claim **57**, wherein

the lamp head further includes

a printed circuit board with a controller to control the one or more light emitting diodes.

66. The flexible LED lamp of claim **57**, wherein

the lamp head further includes

an on/off switch to selectively power on and off the one or more light emitting diodes to turn on and off the single output light.

67. The flexible LED lamp of claim **57**, wherein

the barrel plug and the barrel jack to allow replacement of the lamp head.

68. The flexible LED lamp of claim **57**, wherein

the barrel plug and the barrel jack to allow the lamp head to swivel.

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